

AD-A173 296

QUANTUM LIMITS OF SUPERCONDUCTING HETERODYNE RECEIVERS

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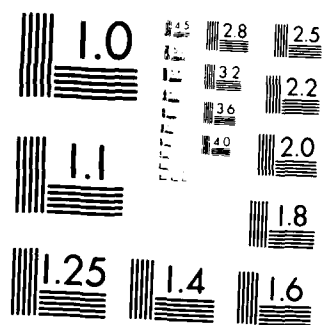
P L RICHARDS 21 AUG 86 AFOSR-TR-86-0033 AFOSR-85-0230

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**AFOSR-TR- 86 - 0833**

ANNUAL TECHNICAL REPORT TO THE  
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH

Grant No. USAF-AFOSR-85-0230

"Quantum Limits of Superconducting Heterodyne Receivers"

Period: May 15, 1985 - May 14, 1986

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Berkeley, California 94720

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR)  
ANNUAL TECHNICAL REPORT TO THE  
AIR FORCE OFFICE OF SCIENTIFIC RESEARCH  
This technical report has been reviewed and is  
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Summary

The goal of this research is to produce quantum limited SIS quasiparticle heterodyne receivers at submillimeter wavelengths. The approach used is to build prototype matching structures for 90 GHz and test them thoroughly. These matching structures will then be scaled to smaller dimensions to investigate their performance at submillimeter wavelengths. Substantial progress has been made toward these goals during the first grant year.

Statement of Work

A 90 GHz measurement system begun under ONR financing which permits accurate measurements of mixer gain and noise has been completed. Two 90 GHz mixer blocks have been evaluated with a variety of types tunnel junctions. They have yielded the first high performance mixers that tune over an entire waveguide band with a single mechanical tuning adjustment. The double-sideband noise temperatures measured were the lowest yet observed for an SIS mixer at 90 GHz.

A quasi-optical mixer has been constructed for 90 GHz. This mixer consists of an SIS tunnel junction integrated with a bow-tie antenna deposited on a substrate in close contact with a hemispherical lens. Tunnel junctions have been fabricated at NBS Boulder using conventional Pb-alloy technology. Tests of these tunnel junctions in the quasi-optical receiver are expected to begin shortly.

Test equipment for evaluating mixers at frequencies up to 600 GHz is being constructed. The approach being used for signal and local oscillator sources is to generate harmonics from 90 GHz Gunn oscillators.



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Publications

P. L. Richards, Analog Superconducting Electronics, Physics Today, March 1986 pp. 54/62.

P. L. Richards, Superconducting Receivers for Molecular Line Astronomy, Bull. Am. Phys. Soc. 31(3), 308 (1986).

D. G. Crete, W. R. McGrath, P. L. Richards, and F. L. Lloyd, Performance of Arrays of SIS Junctions in Heterodyne Mixers, IEEE Trans. Microwave Theory and Techniques (submitted).

P. L. Richards, D. G. Crete, Li Xizhi, W. R. McGrath, D. W. Face, D. Prober, and F. L. Lloyd, Advances in SIS Quasiparticle Mixers, 1986 Applied Superconductivity Conference Abstract, IEEE Trans. Magn. (to be published).

D. G. Crete, A. V. Raisanen, W. R. McGrath, P. L. Richards, and F. L. Lloyd, Low-Noise 80-115 GHz SIS Mixers with a Single Tuning Element, 11th Int. Conf. on Infrared and mm-Waves, Abstract (to be published).

A. V. Raisanen, D. G. Crete, P. L. Richards, and F. L. Lloyd, Low Noise SIS Mixer with Gain for 80-115 GHz, European Space Agency Workshop (to be published).

A. V. Raisanen, D. G. Crete, P. L. Richards, and F. L. Lloyd, Wide-Band Ultra Low Noise mm-Wave Mixers with a Single Tuning Element, 16th European Microwave Conference (to be published).

W. R. McGrath, P. L. Richards, D. W. Face, D. E. Prober, and F. L. Lloyd, Performance of mm-Wave SIS Mixers Employing Pb-Alloy and Ta/PbBi Tunnel Junctions, (to be published).

A. V. Raisanen, D. G. Crete, P. L. Richards, and F. L. Lloyd, Wide-Band, Low Noise mm-Wave SIS Mixers with a Single Tuning Element, Int. J. Infrared and Millimeter Waves (manuscript prepared).

Personnel Associated with the Effort

D. G. Crete, Visitor  
A. V. Raisanen, Visitor  
Li, Xizhi, Visitor  
M. Crommie, Graduate Student Research Assistant  
D. Chrzan, Graduate Student Research Assistant

## Interactions, Coupling Activities

### Invited Talks

P. L. Richards, Josephson Junctions and SIS Detectors, ARO Workshop on Submillimeter Wave Detectors and Receivers, Minneapolis, MN, September 3, 1985.

P. L. Richards, Superconducting Receivers for Molecular Line Astronomy, March Meeting of the American Physical Society, Las Vegas, NV, 31 March-4 April 1986, Bull. Am. Phys. Soc. 31(3), 308 (1986).

P. L. Richards, Superconducting Quasiparticle Tunnel Junctions as Quantum Limited Detectors and Mixers for Microwave Radiation, Seminar, Department of Electrical Engineering and Computer Science, U.C. Berkeley, February 26, 1986.

P. L. Richards, SIS Mixers, West Coast Superconductive Electronics Meeting, Berkeley, CA, March 7, 1986.

P. L. Richards, Superconducting Microwave Heterodyne Receivers Approaching the Quantum Limit, Physics Department Colloquium, Stanford University, Palo Alto, CA, May 20, 1986.

D. W. Face, SIS Mixers in the Quantum Limit, March Meeting of the American Physical Society, 31 March-4 April 1986, Las Vegas, NV, Bull. Am. Phys. Soc. 31(3), 493 (1986).

### Contributed Talks

A. V. Raisanen, W. R. McGrath, P.L. Richards, and F. L. Lloyd, A Simple Integrated Matching Element for SIS Quasiparticle Mixers, IEEE 1985 MTT-S International Microwave Symposium, St. Louis, Mo., June 4, 1985.

D. W. Face, D. E. Prober, W. R. McGrath, and P. L. Richards, Tantalum Based Superconducting Tunnel Junctions for Low-Noise, SIS Millimeter Wave Receivers, 1985 US-Japan Workshop on Josephson Junction Electronics, Kauai, Hawaii, June 18-19, 1985.

### Statement

There have been no inventions or patents disclosures during this grant year.

END

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